

# Regenerative medicine

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**Regenerative medicine** is the process of creating living, functional tissues to repair or replace tissue or organ function lost due to damage, or congenital defects. This field holds the promise of regenerating damaged tissues and organs in the body by stimulating previously irreparable organs to heal themselves. Regenerative medicine also empowers scientists to grow tissues and organs in the laboratory and safely implant them when the body cannot heal itself. Importantly, regenerative medicine has the potential to solve the problem of the shortage of organs available for donation compared to the number of patients that require life-saving organ transplantation, as well as solve the problem of organ transplant rejection, since the organ's cells will match that of the patient.<sup>[1]</sup><sup>[2]</sup><sup>[3]</sup>

Widely attributed (incorrectly as it turns out) to having first been coined by William Haseltine (founder of Human Genome Sciences).<sup>[4]</sup> From the work of Michael Lysaght (Brown University), his team *"first found the term in a 1992 article on hospital administration by Leland Kaiser. Kaiser's paper closes with a series of short paragraphs on future technologies that will impact hospitals. One such paragraph had "Regenerative Medicine" as a bold print title and went on to state, "A new branch of medicine will develop that attempts to change the course of chronic disease and in many instances will regenerate tired and failing organ systems."*<sup>[5]</sup><sup>[6]</sup>

It refers to a group of biomedical approaches to clinical therapies that may involve the use of stem cells.<sup>[7]</sup> Examples include; the injection of stem cells or progenitor cells (cell therapies); another the induction of regeneration by biologically active molecules; and a third is transplantation of *in vitro* grown organs and tissues (Tissue engineering).<sup>[8]</sup><sup>[9]</sup>

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## Pioneers

At the Wake Forest Institute for Regenerative Medicine, in North Carolina, Dr. Anthony Atala and his colleagues have successfully extracted muscle and bladder cells from several patients' bodies, cultivated these cells in petri dishes, and then layered the cells in three-dimensional molds that resembled the shapes of the bladders. Within weeks, the cells in the molds began functioning as regular bladders which were then implanted back into the patients' bodies.<sup>[10]</sup> The team is currently working on re-growing over 22 other different organs including the Liver, Heart, Kidneys and Testicles.<sup>[11]</sup>

Dr. Stephen Badylak, a Research Professor in the Department of Surgery and director of Tissue Engineering at the McGowan Institute for Regenerative Medicine at the University of Pittsburgh, has developed a process which involves scraping cells from the lining of a pig's bladder, decellulising

(making free of cells) the tissue and then drying it to become a sheet or a powder. This cellular matrix powder was used to regrow the finger of Lee Spievak, who had severed half an inch of his finger after getting it caught in a propeller of a model plane.<sup>[12][13][14]</sup> However, Ben Goldacre has described this as "the missing finger that never was", claiming that fingertips regrow and quoted Simon Kay, professor of hand surgery at the University of Leeds, who from the picture provided by Goldacre described the case as seemingly "an ordinary fingertip injury with quite unremarkable healing" and as "junk science".<sup>[15]</sup>

In June 2008, at the Hospital Clínic de Barcelona, Professor Paolo Macchiarini and his team, of the University of Barcelona, performed the first tissue engineered trachea (wind pipe) transplantation. Adult stem cells were extracted from the patient's bone marrow, grown into a large population, and matured into cartilage cells, or chondrocytes, using an adaptive method originally devised for treating osteoarthritis. The team then seeded the newly grown chondrocytes, as well as epithelial cells, into a decellularised (free of donor cells) tracheal segment that was donated from a 51 year old transplant donor who had died of cerebral hemorrhage. After four days of seeding, the graft was used to replace the patient's left main bronchus. After one month, a biopsy elicited local bleeding, indicating that the blood vessels had already grown back successfully.<sup>[16][17]</sup>

## Cord blood and Regenerative Medicine

Because a person's own (autologous) cord blood stem cells can be safely infused back into that individual without being rejected by the body's immune system — and because they have unique characteristics compared to other sources of stem cells — they are an increasing focus of regenerative medicine research.

The use of cord blood stem cells in treating conditions such as brain injury<sup>[18]</sup> and Type 1 Diabetes<sup>[19]</sup> is already being studied in humans, and earlier stage research is being conducted for treatments of stroke,<sup>[20][21]</sup> and hearing loss.<sup>[22]</sup>

Current estimates indicate that approximately 1 in 3 Americans could benefit from regenerative medicine,<sup>[23]</sup> and children whose cord blood stem cells are available for their own potential use could be among the first to benefit from new therapies as they become available. With autologous (the person's own) cells, there is no risk of the immune system rejecting the cells, so physicians and researchers are only performing these potential cord blood therapies on children who have their own stem cells available.

Researchers are exploring the use of cord blood stem cells in the following regenerative medicine applications:

### Type 1 Diabetes

A clinical trial under way at the University of Florida is examining how an infusion of autologous cord blood stem cells into children with Type 1 diabetes will impact metabolic control over time, as compared to standard insulin treatments. Preliminary results demonstrate that an infusion of cord blood stem cell is safe and may provide some slowing of the loss of insulin production in children with type 1 diabetes.<sup>[24]</sup>

## Cardiovascular

The stem cells found in a newborn's umbilical cord blood are holding great promise in cardiovascular repair. Researchers are noting several positive observations in pre-clinical animal studies. Thus far, in animal models of myocardial infarction, cord blood stem cells have shown the ability to selectively migrate to injured cardiac tissue, improve vascular function and blood flow at the site of injury, and improve overall heart function.<sup>[23]</sup>

## Central Nervous System

Research has demonstrated convincing evidence in animal models that cord blood stem cells injected intravenously have the ability to migrate to the area of brain injury, alleviating mobility related symptoms.<sup>[25][26]</sup> Also, administration of human cord blood stem cells into animals with stroke was shown to significantly improve behavior by stimulating the creation of new blood vessels and neurons in the brain.<sup>[27]</sup>

This research also lends support for the pioneering clinical work at Duke University, focused on evaluating the impact of autologous cord blood infusions in children diagnosed with cerebral palsy and other forms of brain injury. This study is examining if an infusion of the child's own cord blood stem cells facilitates repair of damaged brain tissue, including many with cerebral palsy. To date, more than 100 children have participated in the experimental treatment – many whose parents are reporting good progress.<sup>[citation needed]</sup>

As these clinical and pre-clinical studies demonstrate, cord blood stem cells will likely be an important resource as medicine advances toward harnessing the body's own cells for treatment. The field of regenerative medicine can be expected to benefit greatly as additional cord blood stem cell applications are researched and more people have access to their own preserved cord blood.

<sup>[citation needed]</sup> <sup>[28]</sup>"Steenblock Research Institute, umbilical cord stem cell therapy" (<http://www.stemcelltherapies.org/>) . <http://www.stemcelltherapies.org/>.

## See also

- Artificial organ
- Axolotl
- Biomedicine
- Regeneration (biology)
- Rejuvenation (aging)
- Stem Cell Treatments

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## External links

### Less technical further reading

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### Scientific Journals

- Regenerative Medicine (<http://www.futuremedicine.com/loi/rme>)
- Regenerative Medicine Glossary (<http://www.futuremedicine.com/toc/rme/4/4s>)
- Regenerative Dental Medicine Journal (<http://www.rdmj.net>)
- Tissue Engineering (<http://www.liebertonline.com/loi/ten>)

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